BEYOND
Centre of Excellence
for EO Sciences and Services

A Sentinel-based Agriculture Monitoring Scheme

NATIONAL OBSERVATORY OF ATHENS

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IAASARS

Motivation and Legacy

Agriculture monitoring, for the purposes of food security, control of the implementation of sustainable agriculture policies and the improvement of the overall agricultural productivity, is a top priority for the European Union.

RECAP - *fully automated earth observation system for the monitoring of the CAP*

- improve the remote monitoring of CAP Cross Compliance and Greening obligations to assist the Paying Agency inspection processes and at the same time offer farmers a tool supporting them to understand and better comply with the rules.

EOPEN - *extend and scale up the application of the RECAP crop monitoring scheme*

- incorporate big data technologies and other mature ICT solutions for the monitoring of Food Security at national and even continental scales
- address the notion of big data in multiple dimensions; with respect to 1) the area of application - national and international scale, 2) the spatial resolution of thematic information, 3) the volume of data (national scale mosaics of dense time-series of S-1 and S-2), 4) computational efficiency (big data processing technologies).

A comprehensive approach

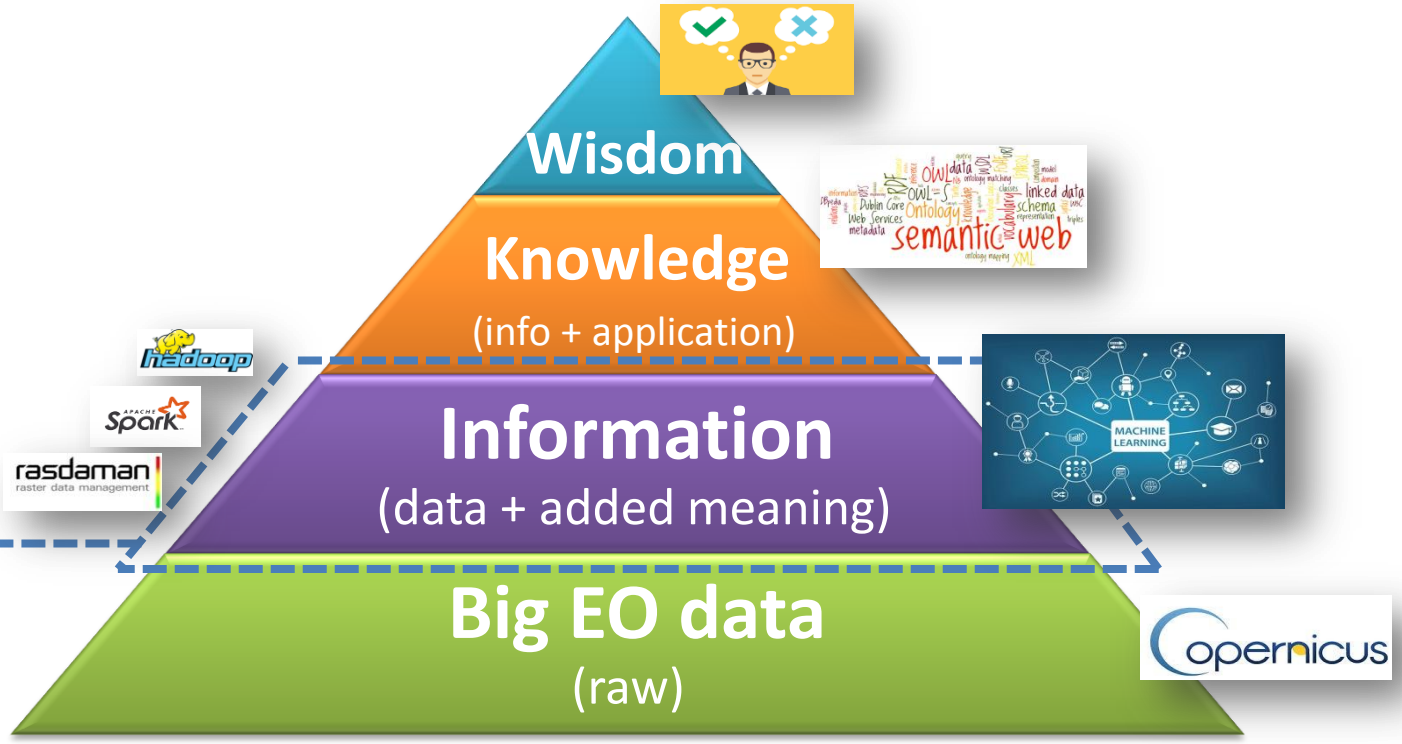
DECISION MAKING

SEMANTIC REASONING

MACHINE LEARNING

BIG DATA (HW+SW)

SENTINEL HUBS



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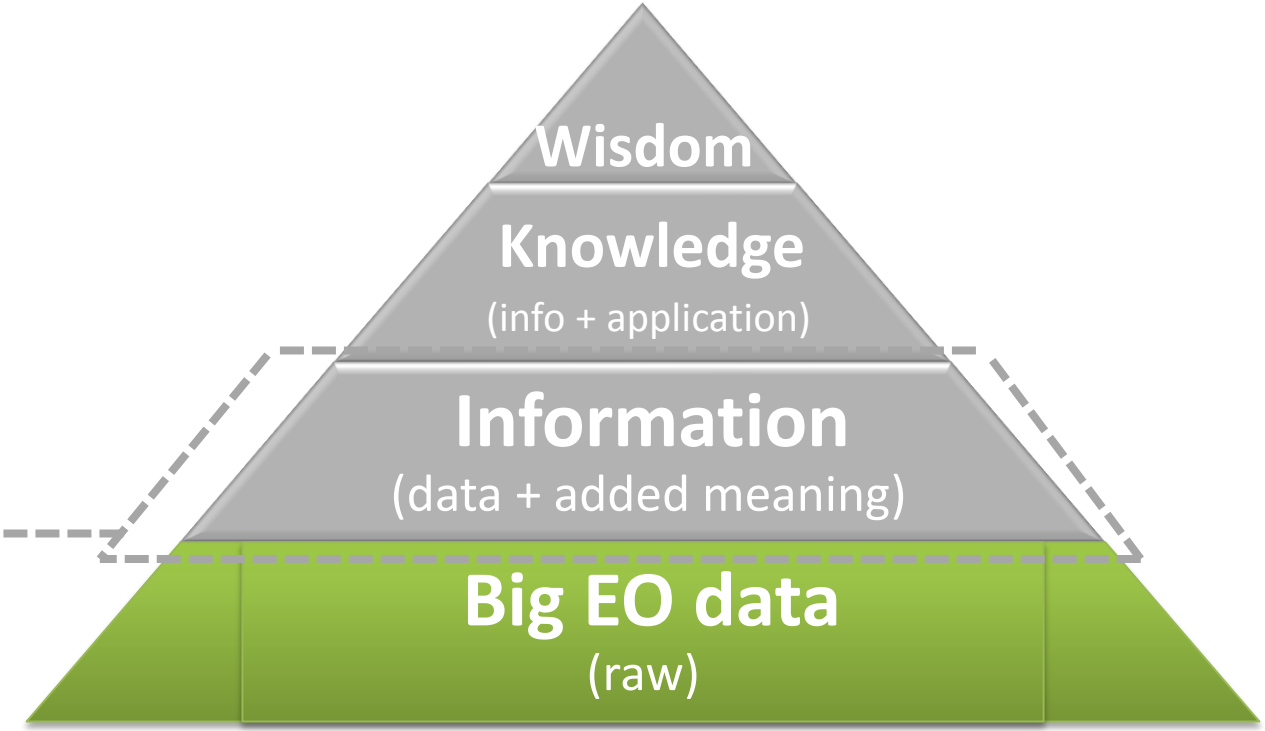
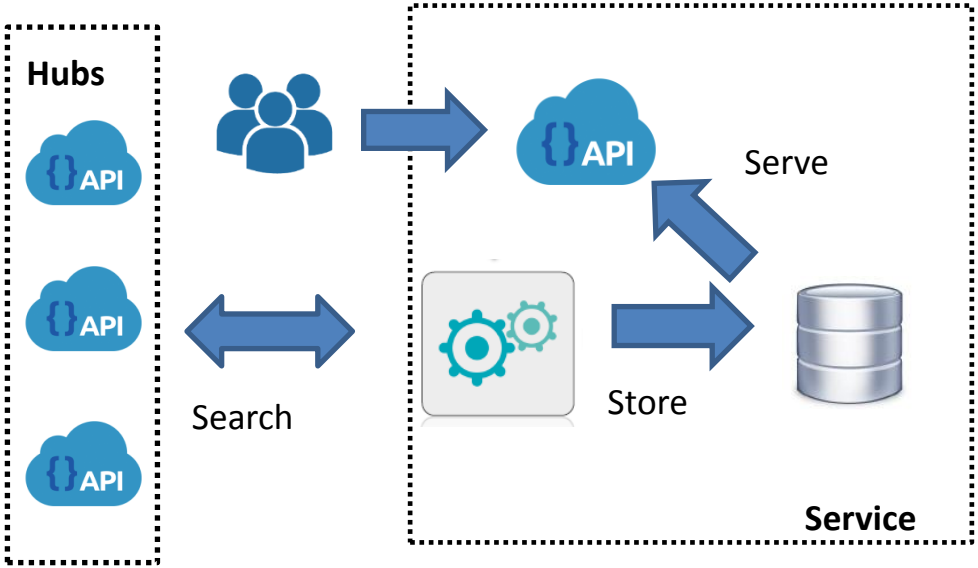


Select the right data

Problem to tackle

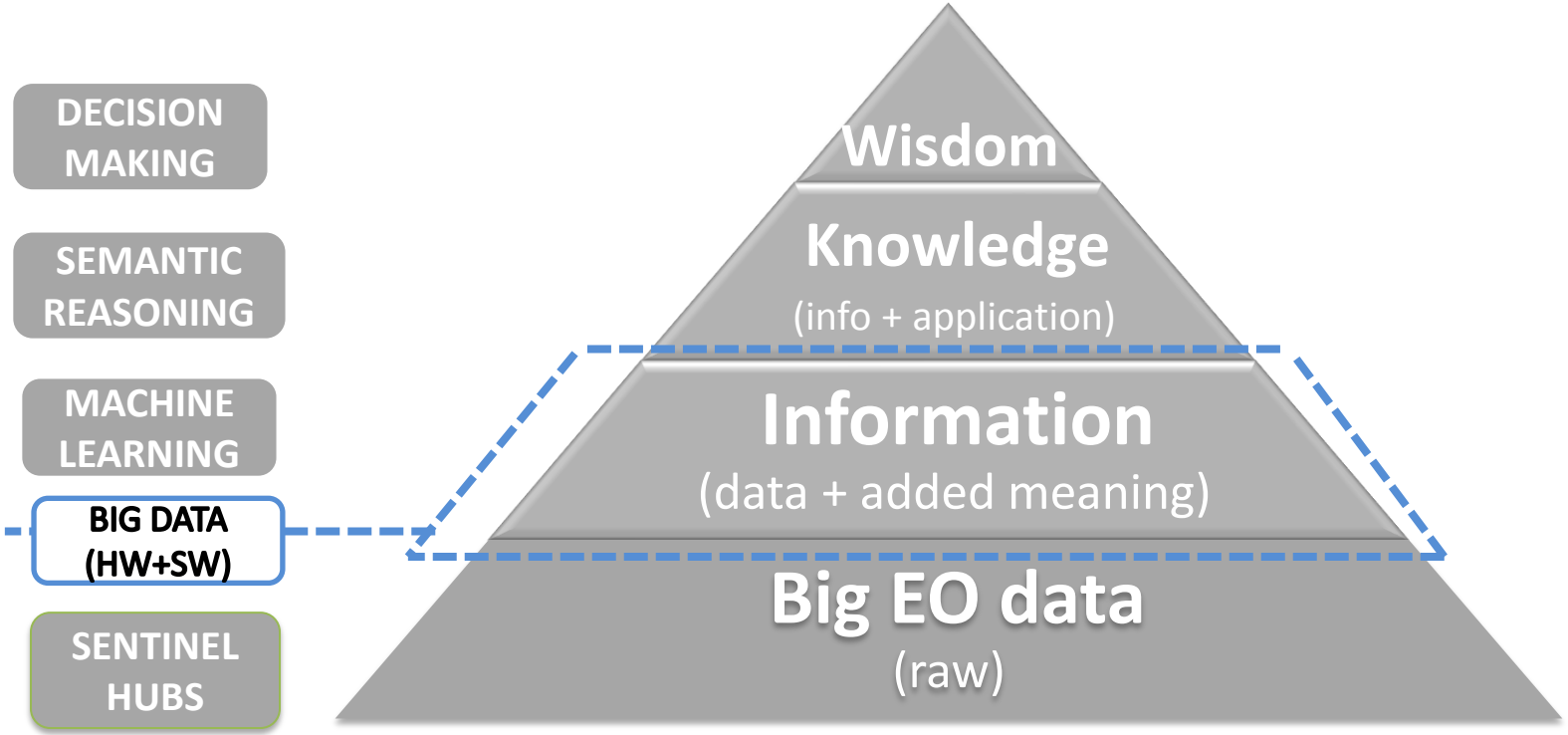
- Data rolling policy
- Availability of different missions and different products per sensor
- Geographic coverage within which Sentinel products are available
- Different performances



Advantages

- No geographic restrictions
- Full availability of all Sentinel missions
- Selection of most appropriate hub to download from

PostGIS django python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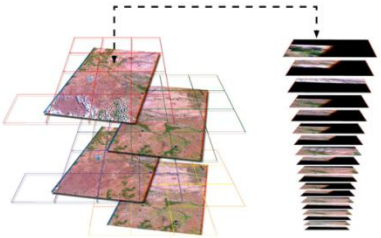
Wisdom
Knowledge
(info + application)
Information
(data + added meaning)
Big EO data
(raw)

Big Earth Observation data

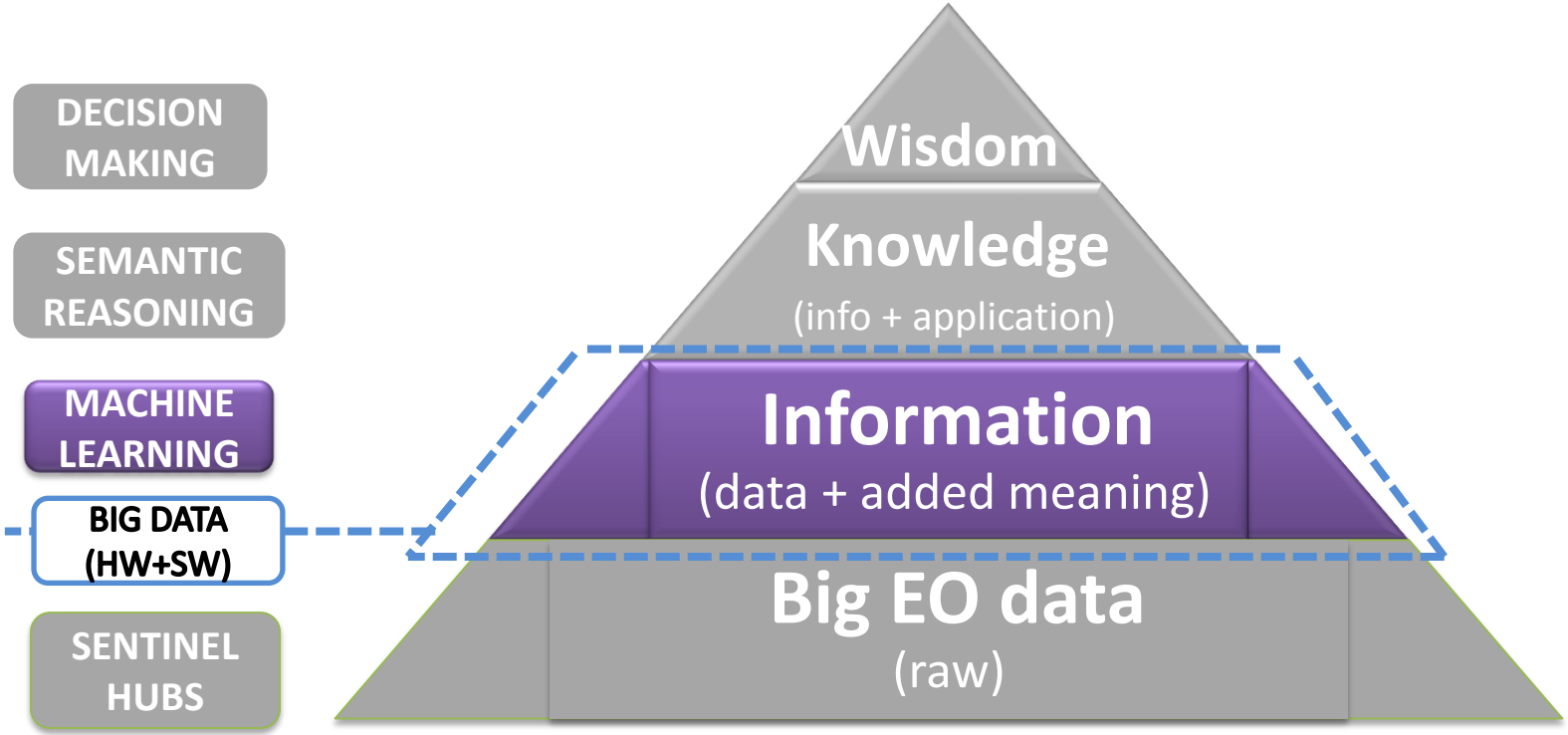
EO data

- Long time-series of Sentinel-1 and Sentinel-2 data
- Tens of TB of information for national scale monitoring
- Solutions: Data cubes & HPC



non EO data

- Geospatial information of the crop parcels in the AOI (LPIS)
- The farmers' declarations on the cultivated crop type in the year of inspection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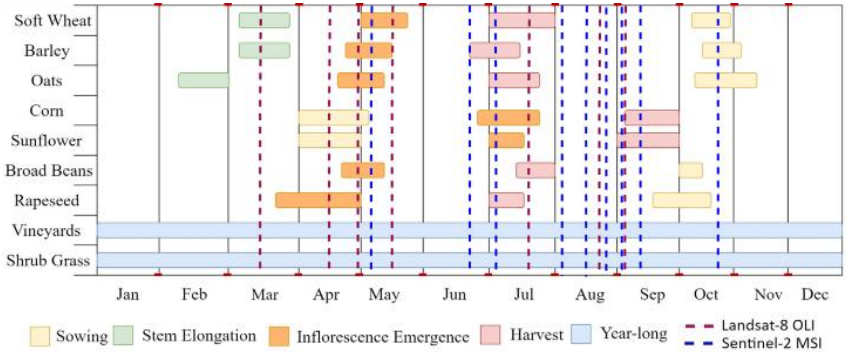
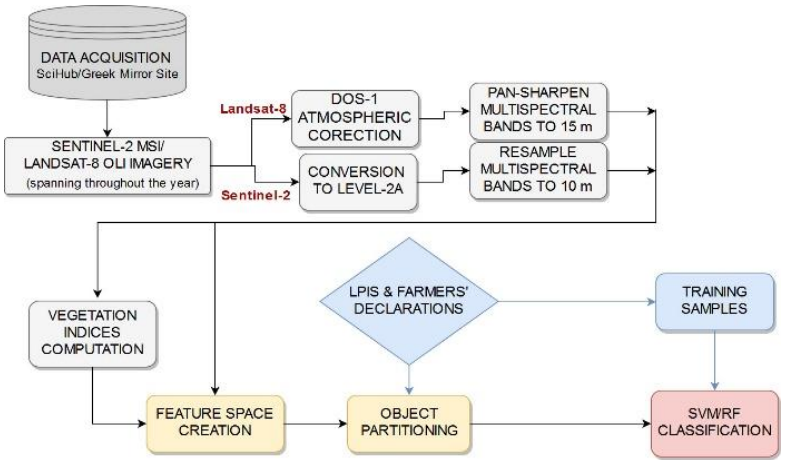
Crop identification

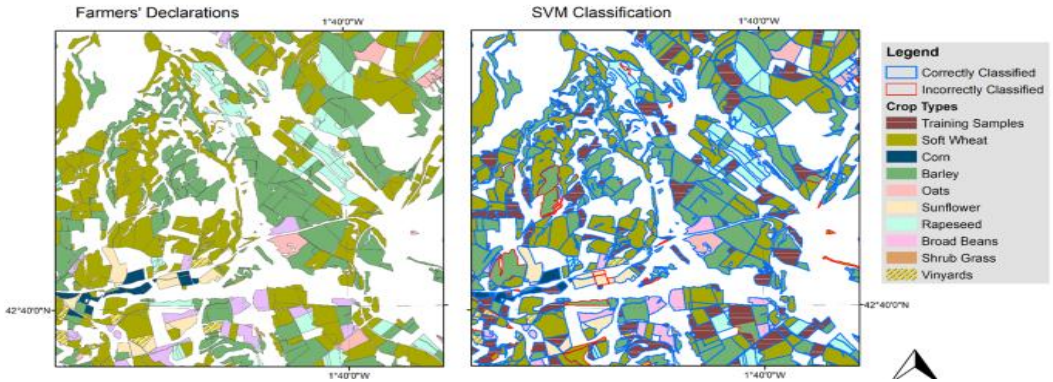


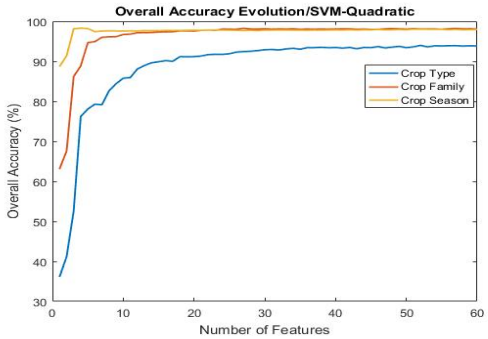


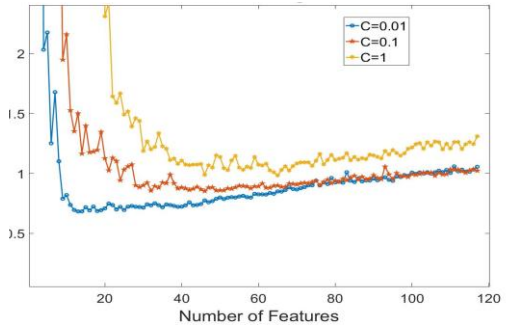
- Multi-temporal approach: phenology is the discriminating information
- Object-based image analysis: the LPIS is utilized to produce the image objects
- Feature space creation
- Tested several algorithms: Weighted k-Nearest Neighbor, Subspace Discriminant, Random Forest, SVM Quadratic

Crop identification

Sitokonstantinou, Papoutsis, et al.,
Remote Sensing 2018
Armesto et al., Copernicus4regions, 2018

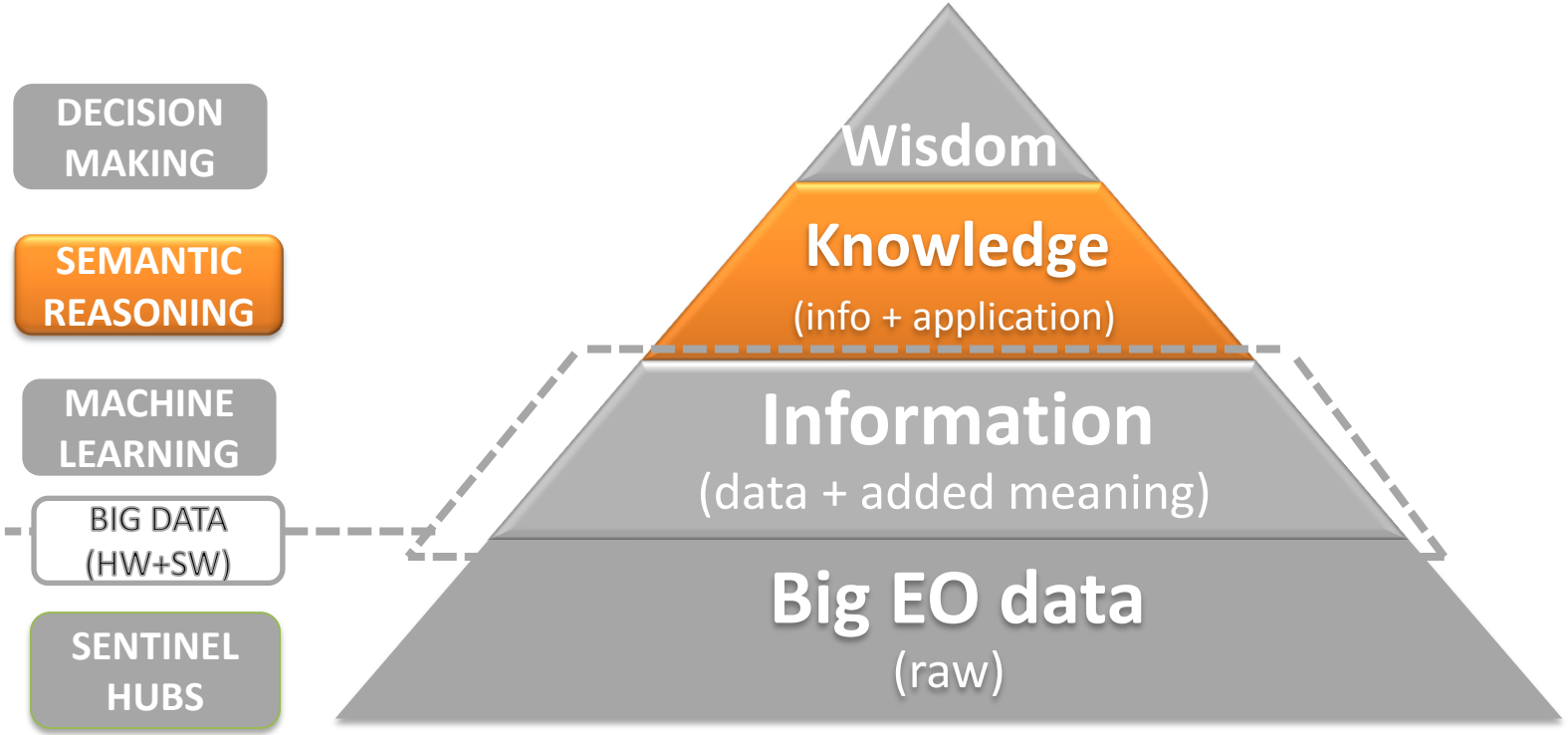






Accuracy > 90%

kappa coefficient > 87%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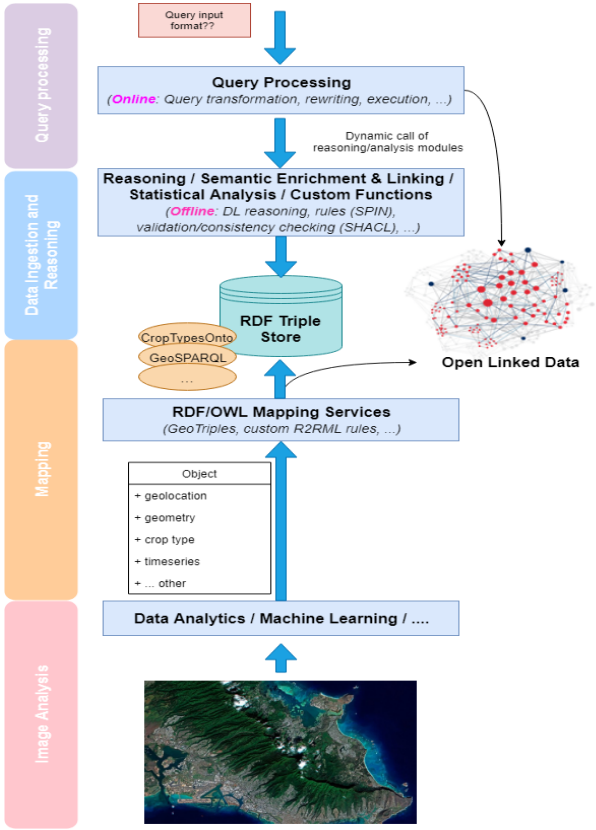
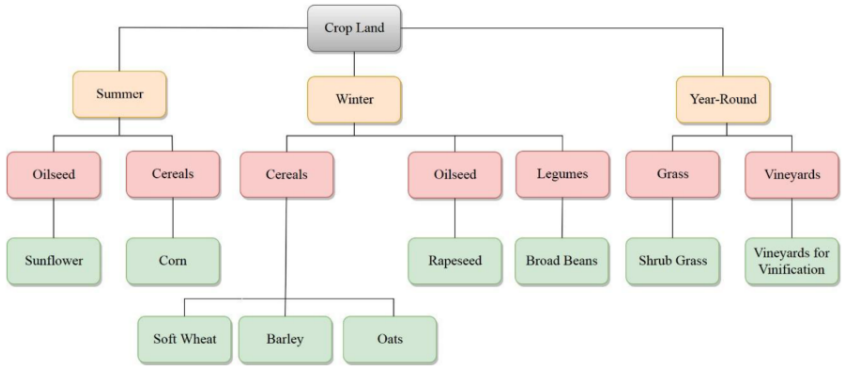
Semantic Reasoning



-Classification refinement

-Address complex CAP rules

-Spatiotemporal querying



Targeted on the spot inspections

- Introduction of the traffic light system for smart sampling based on the posterior probability confidence of the classification decision

Percentage of parcels	Confidence	Accuracy
85%	Green	94%
6%	Yellow	71%
4%	Red	58%
5%	Unreliable	50%
	Overall accuracy	88%
Total number of parcels	12447	

Crop type	Green	Yellow	Red	# parcels
Soft weat	87%	5%	4%	3962
Corn	76%	10%	6%	173
Barley	87%	5%	4%	2584
Oats	79%	7%	6%	739
Sunflower	76%	7%	5%	186
Rapeseed	90%	4%	3%	492
Broad Beans	63%	11%	11%	128
Shrub Grass	58%	13%	12%	181
Vineyards	54%	15%	14%	140
Cherry trees	67%	7%	9%	124

Overall Accuracy= 91%

Smart Sampling

PAs can pinpoint cases of potential breaches of compliance and target their inspections via being provided with:

1. Parcels classified with **high confidence** to **different** crop types than the declared one – potential case of wrongly declared parcel (90% correctly spotted false declarations)
2. Parcels classified with **medium confidence** to **different** crop types than the declared one – potential case of both wrongly declared and wrongly classified parcel
3. Parcels classified with **high confidence** to the **same** crop type as the declared one – no particular interest

Take-home message

- Exploited Sentinel data and ancillary unique datasets provided by the end-users
- Employed pertinent technologies to handle the large volume of data
- Utilized machine learning techniques and semantic reasoning to provide high level knowledge
- Provide paying agencies with actionable information – smart sampling

Thank you!

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